ARENACEOUS FORAMINIFERA FROM THE TYPE KIMERIDGIAN (UPPER JURASSIC)

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ABSTRACT. A series of 105 samples with an average vertical spacing of 12 ft. was collected to span the Kimeridge Clay of the Dorset Coast. The dominant element of the foraminiferal faunas comprised members of the family Lagenidae; agglutinating forms were an important accessory.

The proportions of potentially agglutinable materials in each of twenty-seven samples were determined. A study was also made of the materials used by the 'arenaceous' foraminifera in building their tests. The two sets of results indicate that species agglutinate a preferred grain-size and, in some cases, a preferred type of material. This agrees broadly with Hofker's (1953) conclusions.

Systematic descriptions are given of twenty-five species of arenaceous foraminifera, referred to eight genera. Three species are new.

INTRODUCTION

BY contrast with the foraminifera of the rest of the Jurassic those in the uppermost part have received scant attention. In his account of the Kimeridge Clay of England, Blake (1875) gave only a list of foraminifera. Woodward (1895, pp. 399–401) gives lists of foraminifera, and a shorter list of forms from the Hartwell Clay was given by Chapman (1897). The latter were described by Neaverson (1921), but only a brief note is made of many species. Finally, Waterston (1951) included a list of genera found in the Kimeridgian of Eathie, Cromarty, Scotland.

On the European continent the foraminifera are known in more detail. Alth (1882) described the foraminifera of the Nisniow Limestone, later redescribed by Cushman and Glazevski (1949). The most comprehensive account of the Polish forms is by Bielecka and Pożaryski (1954), but the important work on Russian foraminifera by Myatliuk (1939) has not been seen. Of lesser importance are papers by Chapman (1900), Tobler (1928), Mohler (1938), and Klingler (1955).

It was thought best to begin an investigation of the British Kimeridgian foraminifera from the rocks exposed along the Dorset Coast between Weymouth and Swanage, as here the whole formation is exposed and Arkell (1947, pp. 64–88) has provided a detailed account of the sections. Moreover, d'Orbigny selected this as the type-area of the Kimeridgian Stage. The subdivision of the Kimeridge Clay (the exact equivalent of the Kimeridgian Stage) given by Arkell (1947) is adopted here. Some members of the Kimeridge Clay have been given names, e.g. Crushed Ammonoid Shales, see text-fig. 1. Attention was concentrated on two areas, first, the gentle southern limb of the Purbeck anticline from Kimeridge Bay to Hounstout, where samples from the middle of the *pseudomutabilis* zone to the top of the formation were obtained, and second, the cliffs between Shortlake and Osmington Mills (the Black Head sections), where the *baylei*, *cymodoce*, *mutabilis* zones and the lower part of the *pseudomutabilis* zone were sampled. From this composite section of some 1,200 ft. of strata, 105 samples were collected. Each sample was given a code number of three elements representing locality (e.g. 'Do-' for Dorset Coast), ammonite zone (e.g. 'Mu' for *Rasenia mutabilis*), and position in the zone (samples numbered from oldest to youngest).

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Standard preparation methods were employed. All specimens were picked from most residues and further more rapid methods showed that the other samples yielded a representative fauna. The material picked from each sample was sorted initially into 'form-groups' (species, species-groups, or closely allied species). A few specimens from each form-group, selected to show the range of variation within that group, were mounted for further study. Thus the variation of each species both at a given horizon and in time could be determined. This led to a broad interpretation of the species, some of which can be subdivided. Two or more of these sub-specific groups of a single species may occur in the same sample so cannot be regarded as sub-species or varieties. They are taken here as lying outside the scope of the International Rules and will be distinguished by capital letters (e.g. *A. agglutinans* A, *A. agglutinans* B, &c.).

Only the Jurassic literature, and in some cases Ellis and Messina's Catalogue, were consulted in compiling the synonymies which should therefore be taken only as lists of morphologically similar forms. Type and figured specimens have been deposited in the British Museum (Natural History).

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NATURE OF THE RESIDUES

The Kimeridgian of the type locality is represented by an argillaceous formation, the Kimeridge Clay. At first sight only two lithologies seem to occur—shales, with the laminations well or poorly developed, and cementstone bands, thin compact limestones. As the treatment of limestones involves special techniques they have not been considered here. A closer inspection of the 'shales' shows that many rock-types can be found, ranging from soft, black clays and shaly clays through hard, calcareous clays (Arkell's 'Dicey clays') and soft shales to hard, splintery shales and even sulphurous paper shales. In addition nearly all the beds contain arenaceous material which, in some cases is sufficiently common to be visible macroscopically (the 'Marls' of stratigraphers). The distribution of these rock-types in the vertical sequence is broadly cyclical (text-fig. 1). The soft clays and shales predominate in the lower and upper parts of the formation while the hard shales are found mainly in the middle. The sandy clays are found only at the extreme base and towards the top.

The lithological characters may be summarized as follows:

1. The *baylei* zone. Sandy clay.
2. The two *Rasenia* zones. Soft, gypsiferous clays becoming shaly near the top.
3. The *pseudomutabilis* and two *Gravesia* zones. Hard, often paper shales.
4. The *Subplanites* and *pectinatus* zones. Alternations of hard shales and dicey clays or soft shales, the clays becoming dominant upwards.
5. The two *Pavlovia* zones. Soft shales and clays below, becoming sandy clays upwards.

Thin compact limestones occur in 3 and 4. Their names and horizons are indicated in text-fig. 1.

Although agglutinating foraminifera occur throughout the formation only a few species range from bottom to top. Twenty-seven samples were selected for detailed study and their residues analysed. In the following paragraphs a comparison will be made of the materials available, as shown by these samples, and the materials agglutinated.

When the samples were prepared the sole object was to separate foraminifera, of 200 μ diameter or over, from the much finer-grained clay minerals. As a result much material of grain size less than 20 μ has been washed away, including in the upper size range, potentially agglutinable material. A partial check on this lost material can be made from incompletely broken down pieces of shale or marl, from which it seems the loss is slight.

The residues contained eight different classes of material which have been considered as available for agglutination. Gypsum crystals were abundant in residues from the lowest three zones, and less regularly in the *rotunda* zone. This has been ignored as being a secondary constituent.

Quartz. Occurred in every residue with the exception of Do-Pa 8. The usual varieties were clear and yellow-tinted grains, but grey, white, pink, green, and brown-tinted grains also occurred. Included here are two much rarer types, a red garnet and minute lydite pebbles.

Shell fragments. Broken pieces of lamellibranch, gastropod, and ammonite shell were always present, and in many cases formed the bulk of the residue. I think that the presence of patches of pyrite covering broken edges shows that at least some fragmentation was contemporaneous with sedimentation and did not happen during the preparation of the samples.

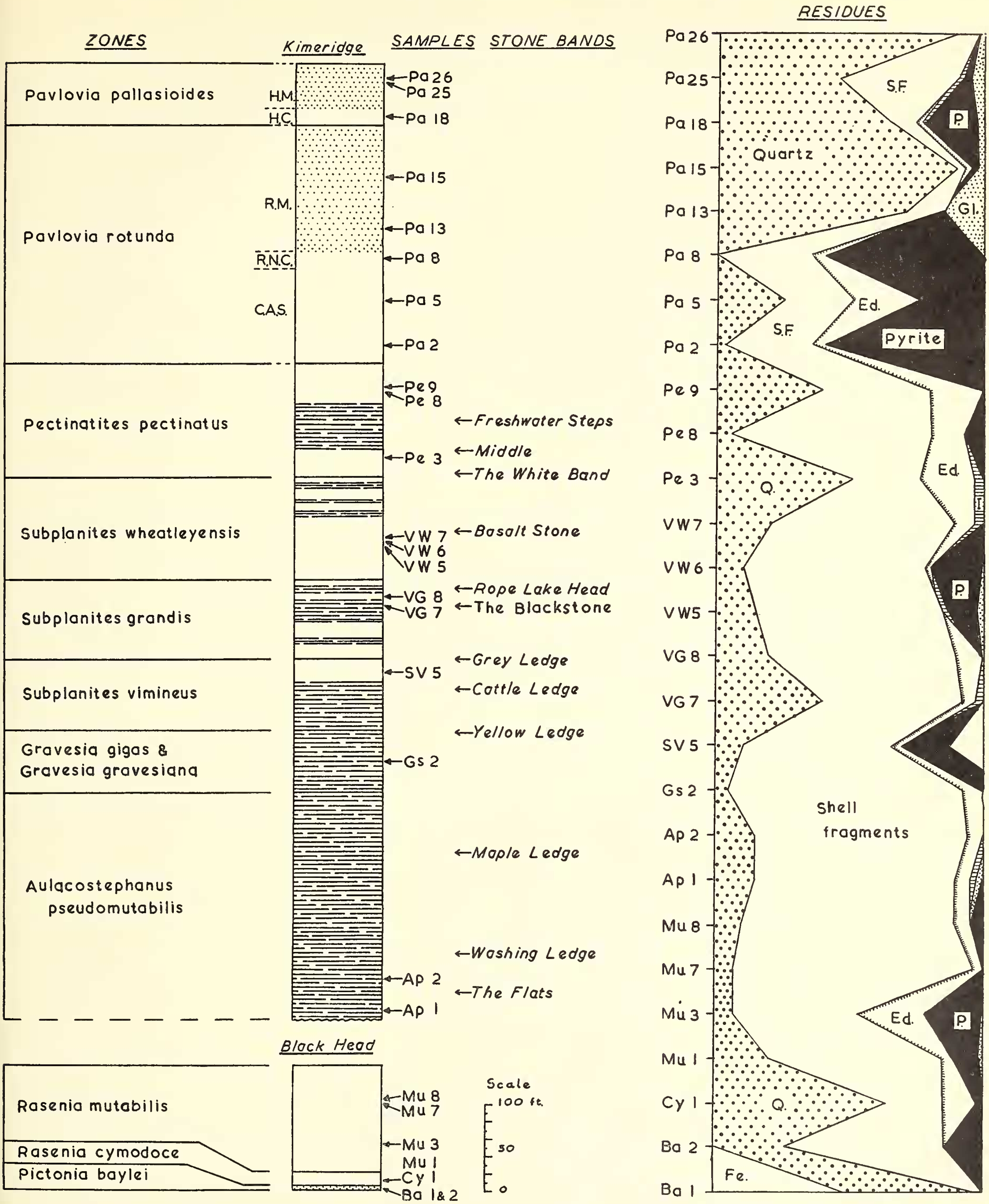
Echinoderm remains, &c. Under this heading are grouped unbroken but disarticulated units. Echinoid plates, spines, and dactylous pedicellariae occurred frequently. Crinoid ossicles of the *Pentacrinus* type and Holothurian spicules were rare, but Ophiuroid ossicles were sometimes common. Also included are fish teeth, fin radials, scales and vertebrae, and Lepadomorph barnacle plates.

'*Inoceramus*' *prisms.* These were never an important element of the residues. All prisms from thick-shelled Lamellibranchs were included here regardless of whether they were derived from *Inoceramus* or not.

Pyrite occurred as sticks and pellets with either a fine-grained, smooth surface or a mammilate surface. With these were found minute globules, the same size as the mammilae of the larger pellets which might therefore be aggregate masses, and perfect crystal cubes. The grain size of these latter types usually falls within the 5–15 μ range. In addition to these 'independent' types, pyrite was also found filling pores in, replacing, or forming a skin on shell material, wood, &c. Love (1957) has shown that the small globules have an organic origin and were penecontemporaneous with sedimentation. I had independently come to the conclusion that at least some of the pyrite was available on the sea floor for agglutination.

Iron pellets. In the *baylei* zone of the Black Head area the lateral equivalent of the Abbotsbury Iron Ore is, in part, a sandy clay with some of the characteristic pellets still occurring. This material, due probably to its large grain size and unwieldy shape, was never agglutinated.

Iron flakes. This constituent occurred in a few samples as irregular, rusty plates. In one sample from the *vimineus* sub-zone, it made up 15 per cent. of the residue. It was never agglutinated.



TEXT-FIG. 1. Zonal classification, lithologies, and available materials of the Dorset Coast Kimeridgian. Left-hand column: zonal scheme after Arkell (1956). Key to lithologies: stippled—sandy clay; shaded—hard shales; blank—soft shales and clays. R.N.C.—*Rotunda* Nodule Clays; R.M.—*Rhynchonella* Marls; H.C.—Hounstout Clay; H.M.—Hounstout Marls; C.A.S.—Crushed Ammonoid Shales. Horizons of the twenty-seven selected samples are indicated. Right-hand column: proportional occurrences of potentially agglutinable materials: Fe.—iron pellets; coarse stipple Q.—quartz; S.F.—shell fragments; shaded edge Ed.—echinoderm fragments, &c.; black P.—pyrite; shaded I—'*Inoceramus*' prisms; fine stipple Gl.—glauconite; blank near right-hand edge—iron flakes.

Glauconite. This is usually a rare element of the residues and is agglutinated along with garnet as a 'quartz substitute'.

The proportional occurrences of these eight elements are shown in the right-hand column of text-fig. 1. No attempt has been made to give absolute quantities as the object is to show the relative availability of any potentially agglutinable material at a given horizon.

It can be seen that quartz is usually present, making up a large proportion of the residue in the *baylei* zone and the top of the *Pavlovia* zones. At these horizons the quartz is also of a coarser grain. Although shell fragments form the bulk of the residues through much of the column, and made up 47 per cent. of the residue from Do-Mu 3, this was the only time they were extensively utilized for agglutination. Pyrite was observed throughout the Kimeridgian so availability alone would not account for its utilization in the middle and upper parts of the succession. The other constituents made up only a minor part of the residues.

UTILIZATION OF THE AVAILABLE MATERIALS

In investigating the utilization of materials two approaches each yield useful information. The first is to observe the differences in materials agglutinated by the same species from different samples; the long-range forms are of special interest here: and the second, to compare the materials used by different species from the same sample.

The grain sizes of agglutinated materials are for convenience divided into three classes, 5–20 μ material called fine grained, 20–60 μ medium grained, with a sub-division into fine-medium and coarse-medium, and over 60 μ coarse grained.

(*a*) Variation in the long-range forms. *Proteonina difflugiformis* (Brady) shows a preference for medium-grained quartz, but variation does occur in both the grain size and type of material. In the *baylei*, *cymodoce*, and *mutabilis* zones clear quartz with grain sizes between 40 and 60 μ was usually agglutinated. Occasionally individuals include finer material and in some samples the maximum grain size was only 30 μ. In some forms pyrite and garnet were included to a small extent. In sample Do-Mu 3 up to 10 per cent. of the material was broken shell of a similar grain size to the quartz. From the *pseudomutabilis* zone to the lower part of the *rotunda* zone the dominant material was finer grain quartz, but from the *wheatleyensis* sub-zone onwards up to 40 per cent. 5 μ pyrite was included. Above the Crushed Ammonoid Shales there was a gradual return to medium-grained quartz, with a corresponding diminution in the amount of pyrite.

Ammobaculites agglutinans (d'Orbigny) has a similar history. In the lower zones fine-medium quartz was the usual material with shell fragments as a minor constituent in Do-Mu 3. In the middle of the Kimeridgian there was a slight reduction in grain size to 10–20 μ, and in a variant with a slender test much 5 μ pyrite was included. In the *pectinatus* zone the normal forms began to include a small amount of pyrite but towards the top of the *Pavlovia* zones there was a return to the fine-medium grain quartz. This species is clearly more conservative than *P. difflugiformis* but appears to follow the same trend.

Ammobaculites deceptorius (Haeusler) always agglutinated finer-grained material, 20–30 μ quartz in the *baylei* zone, and in the *mutabilis* zone utilized more pyrite than any of the above forms. By the *wheatleyensis* sub-zone a large part of the test was made up of 5–10 μ pyrite, and in the *pectinatus* zone the amount rose to 50 per cent. Again, in the *pallasioides* zone there was an increase in the grain size, with specimens using a mixture of 10–30 μ quartz and a little 5 μ pyrite.

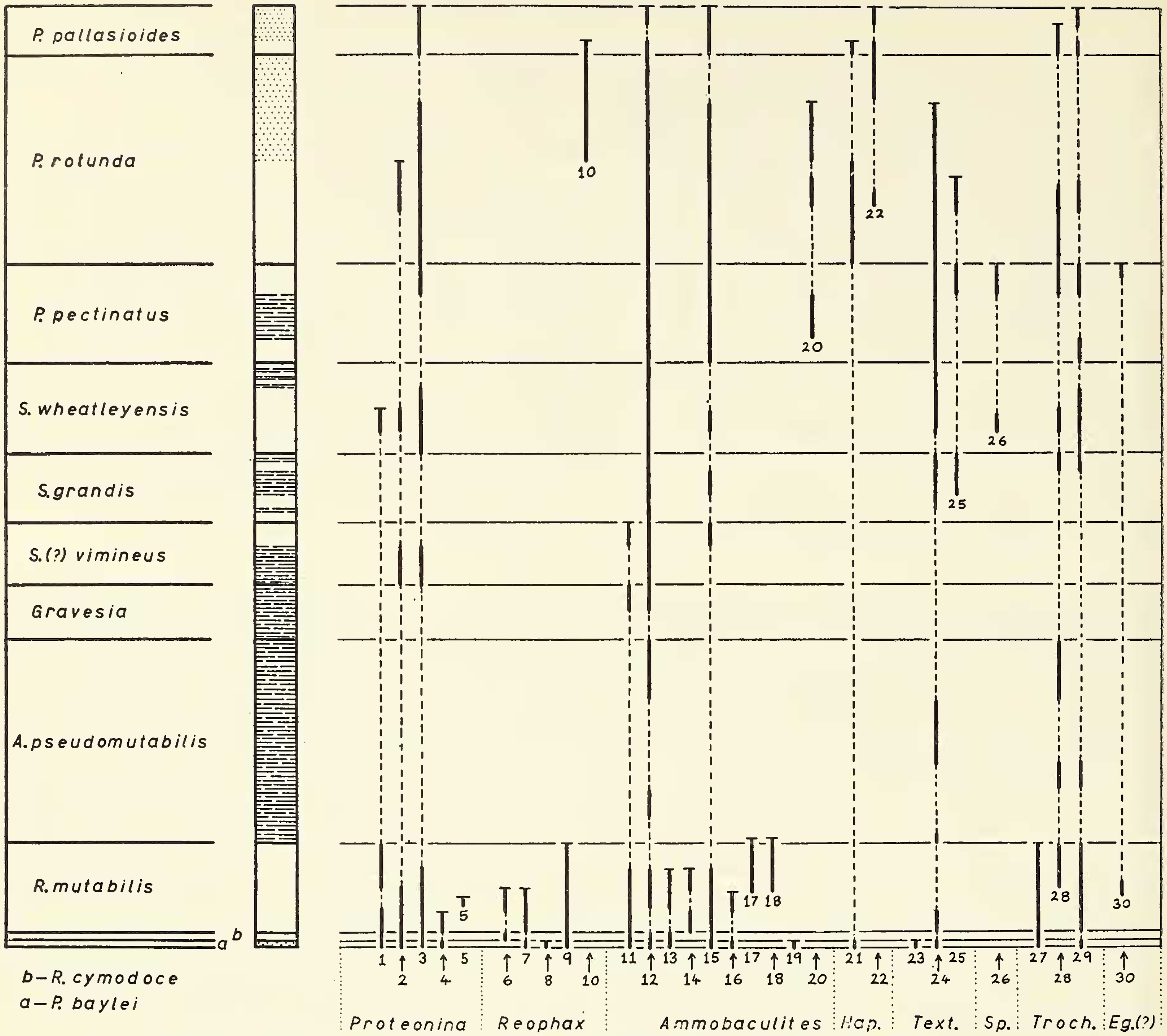
From the *pseudomutabilis* zone to the *pectinatus* zone *Textularia jurassica* (Gümbel) agglutinated fine-grain material. For most of the range pyrite alone was used but towards the top some 10 μ garnet and quartz were added as minor constituents. This dominance of pyrite is in marked contrast to the species described above, where it rarely makes up more than half of the test and is usually present to a much smaller degree.

Trochammina globigeriniformis (Parker and Jones) agglutinated medium-grained quartz in the *baylei* zone and fine-grained quartz in the *mutabilis* zone, but by the *pseudomutabilis* zone only pyrite was agglutinated. Through the *Subplanites* zone pyrite of 5–15 μ grade dominated but in the *pectinatus* zone more than 50 per cent. of the test in some specimens was made up of fine-grained quartz. In the *Pavlovia* zones quartz was usually dominant, though with up to 50 per cent. pyrite present, but there was no increase in grain size in the upper part.

(*b*) Variation in the short-range forms. In the *baylei* zone the grain size utilized was, in general, coarser than in the later zones, but *Ammobaculites laevigatus* Lozo, a large form apparently confined to this zone, agglutinated only fine-grained quartz. *Ammobaculites* cf. *coprolithiformis* (Schwager) occurred in the same zone, where its test was composed of many large quartz grains in a 30 μ quartz matrix, and in the *mutabilis* zone where large shell fragments replaced the large quartz grains. *Ammobaculites subaequalis* Myatliuk and *Ammobaculites braunsteini* Cushman and Applin, large forms present in the upper part of the *mutabilis* zone, used only medium-grained quartz. From these four cases it would appear that there is no correlation between the coarseness of material employed and the size of the adult foraminifera.

Two forms restricted to the sandy clays at the top of the *Pavlovia* zones again show contrasting characters. *Reophax hounstoutensis* sp. nov. used coarse-grain material, dominantly 70–80 μ quartz with occasional larger grains. Over 90 per cent. of the material is yellow quartz with only a small amount of clear and white quartz. This gave the species a very uniform appearance both as to grain size and colour. *Haplophragmoides haeusleri* sp. nov. was similar in using a grain size in the 70–100 μ range but appeared to be much more 'fashion conscious'. Individual specimens employed a variety of colour schemes by combining two or rarely three of the available coloured quartzes. Yellow and clear, grey with subordinate clear, yellow with few glauconite grains and yellow, subordinate clear and rare garnet were some of the more common fashions. A colour scheme, once decided upon, was adhered to throughout the test with great constancy. There is, therefore, a definite selective capacity as regards both colour and grain size, but while the grain size is a character uniform to the whole species the choice of colour was a matter of individual discretion. Such cases of colour selectivity can be seen in many other species.

(*c*) Conclusions. 1. Grain size is the most important single character but long-ranging species, perhaps by their very nature, can tolerate somewhat restricted changes in the size used.



TEXT-FIG. 2. Table showing ranges of arenaceous foraminifera in the Kimeridgian.

1, *Proteonina difflugiformis* A. 2, *P. difflugiformis* B. 3, *P. difflugiformis* C. 4, *P. difflugiformis* D. 5, *P. conferrens*. 6, *Reophax sterkii*. 7, *R.* cf. *variabilis*. 8, *R. scorpiurus*. 10, *R. hounstoutensis*. 11, *Ammobaculites agglutinans* A. 12, *A. agglutinans* B. 13, *A. agglutinans* C. 14, *A.* cf. *hockleyensis*. 15, *A. deceptorius*. 16, *A.* cf. *coprolithiformis*. 17, *A. subaequalis*. 18, *A. braunsteini*. 19, *A. laevigatus*. 20, *A. sp. juv*. 21, *Haplophragmoides latidorsatum*. 22, *H. haeusleri*. 23, *Textularia agglutinans*. 24, *T. jurassica*. 25, *T. auensteinensis*. 26, *Spiroplectammina biformis*. 27, *Trochammina squamata*. 28, *T.* cf. *nitida*. 29, *T. globigeriniformis*. 30, *Eggerella? meentzeni*.

2. Quartz or 'quartz substitute' (glauconite, garnet, &c.) is the preferred material for many species with medium and coarse-grained tests.

3. Pyrite is an important element only in species with fine-grained tests, either: (*a*) In species such as *T. jurassica* where it is the preferred material. (*b*) In species such as *T. globigeriniformis* where the preferred material is fine-grained quartz, but pyrite is readily acceptable as a substitute and may occur in amounts over 50 per cent. (*c*) In some fine-medium grain forms where quartz is the preferred material a slight change in grain size may bring the species into the pyrite range. Then pyrite is accepted with varying degrees of reluctance and rarely exceeds 50 per cent. of the total amount.

4. Shell fragments were utilized only once, in sample Do-Mu 3, but in this case, of the eight species recorded, one, *Proteonina conferrens* sp. nov. used it as a preferred material and appears to be restricted to this sample, *A.* cf. *coprolithiformis* used it as a coarse-grained material in the absence of a suitable size of quartz, as did *Reophax sterkii* Haeusler 1890. Two medium-grained forms, *P. difflugiformis* and *A. agglutinans*, employed it as a subordinate material, and the three fine-grained forms, *A. deceptorius*, *T. globigeriniformis*, and *Eggerella*(?) *meentzeni* (Klingler), did not use it. There is clear correlation here between grain size and usage, but this cannot be the only factor or shell fragments would have been more widely used.

5. Selection for colour is made by individuals and is not, of necessity, a specific character.

6. Echinoderm and fish remains were rarely used, due probably to their prohibitive size.

7. '*Inoceramus*' prisms were used as a minor constituent in one species, *P. difflugiformis*, in one sample, Do-Pa 2. Wider usage was not restricted by non-availability.

Hofker (1953) considered that each species chose its material for agglutinating as a genetic character of the species. He thought that the size, chemical composition, and shape of the particles were equally important. In contrast to these conclusions, based on observations from a large part of the geological column, Slama (1954) reported laboratory experiments on species of *Ammobaculites*. His specimens agglutinated all sizes of material from silt grade, forming the substratum of their natural environment, to the coarse quartz of the laboratory tank, but when 500 grade Carborundum was available, agglutinated this in preference to coarser materials. The results of the present study agree with those of Hofker; no parallel to Slama's observations could be seen.

SYSTEMATIC DESCRIPTIONS

Proteonina difflugiformis (Brady)

Plate 54, figs. 1–4

Reophax difflugiformis Brady 1879, p. 51, pl. 4, fig. 3.
Haplophragmium lagenarium Berthelin 1880, p. 21, pl. 1, fig. 2.
Reophax scorpiurus Montfort, Haeusler 1883*b*, p. 27, pl. 2, fig. 7.
Reophax difflugiformis Brady, Haeusler 1890, p. 26, pl. 3, figs. 1, 2; pl. 5, figs. 25–27.
Proteonina difflugiformis (Brady), Paalzow 1917, p. 15.
Proteonina compressa Paalzow 1932, p. 90, pl. 4, figs. 2, 3.
Proteonina ampullacea (Brady), Franke 1936, p. 13, pl. 1, figs. 7*a*, *b*.
Proteonina difflugiformis (Brady), Bartenstein and Brand 1937, p. 128, pl. 1*a*, fig. 1; pl. 1*b*, figs. 1, 2; pl. 2*a*, fig. 1; pl. 2*b*, fig. 3; pl. 3, fig. 1; pl. 4, fig. 1; pl. 5, fig. 1; pl. 6, figs. 2*a*, *b*; pl. 8, figs. 1*a*–*d*; pl. 10, figs. 1*a*–*c*; pl. 11*a*, figs. 1*a*–*c*.
Proteonina ampullacea (Brady), Bartenstein and Brand 1937, p. 128, pl. 8, figs. 2*a*, *b*; pl. 10, figs. 2*a*, *b*.

Description. Test egg-shaped to flask-shaped in lateral view, circular or somewhat compressed in cross-section. The agglutinated material is usually 40–60 μ quartz though some shell fragments and pyrite may be included. The grains are close set with little silicious cement. The aperture is simple, terminal, varies in shape with the cross-section of the test and may have an associated neck.

Remarks. Variation occurs both in the lateral outline, particularly the development of the apertural neck, and in the cross-section. Four stages have been selected to illustrate the former. Variant A (Pl. 54, fig. 1) has an egg-shaped test with no marked narrowing towards the aperture; B (Pl. 54, fig. 3) has its aperture at the apex of a cone which forms half or more of the test; C (Pl. 54, fig. 2) has a test consisting of a sub-spherical body chamber with a distinct, short neck, and D (Pl. 54, fig. 4) is a slender form with a long neck and a flared lip to the aperture. The mode for the species falls between B and C. The extremes were rare and almost unknown above the Lower Kimeridgian.

Jurassic forms of *Proteonina* with a circular cross-section have usually been identified with *P. difflugiformis* (Brady) but the compressed (or possibly squashed) forms have often been referred to different species. Thus Paalzow (1932) placed such forms in *P. compressa* sp. nov., and both Franke (1936) and Bartenstein and Brand (1937) referred similar specimens to *P. ampullacea* (Brady). Parker and Phleger (1951) have shown that in some Recent species there is primary compression of the test, yet in fossil specimens from argillaceous rocks it would be unwise to speciate solely on this criterion. The Kimeridgian specimens showed all intermediates between a circular and a completely squashed cross-section.

Specimens of *Reophax difflugiformis* from the Brady Collection, all labelled syntypes, are preserved on three slides in the British Museum (Natural History). ZF 2267 has five specimens of which one was figured. All are small forms with a slender neck and agglutinated fine quartz grains. The single specimen on ZF 2268 is larger and agglutinated sponge spicules. In addition to this 'Challenger' material there are twenty-nine specimens collected on the 'Porcupine' expedition and mounted on slide ZF 2269. These forms are nearly twice the size of those on ZF 2267 and agglutinated medium quartz grains in a way that left the outer surface rough. The 'Challenger' specimens may not be conspecific with the 'Porcupine' specimens, which agree well with the Kimeridgian material.

Proteonina conferrens sp. nov.

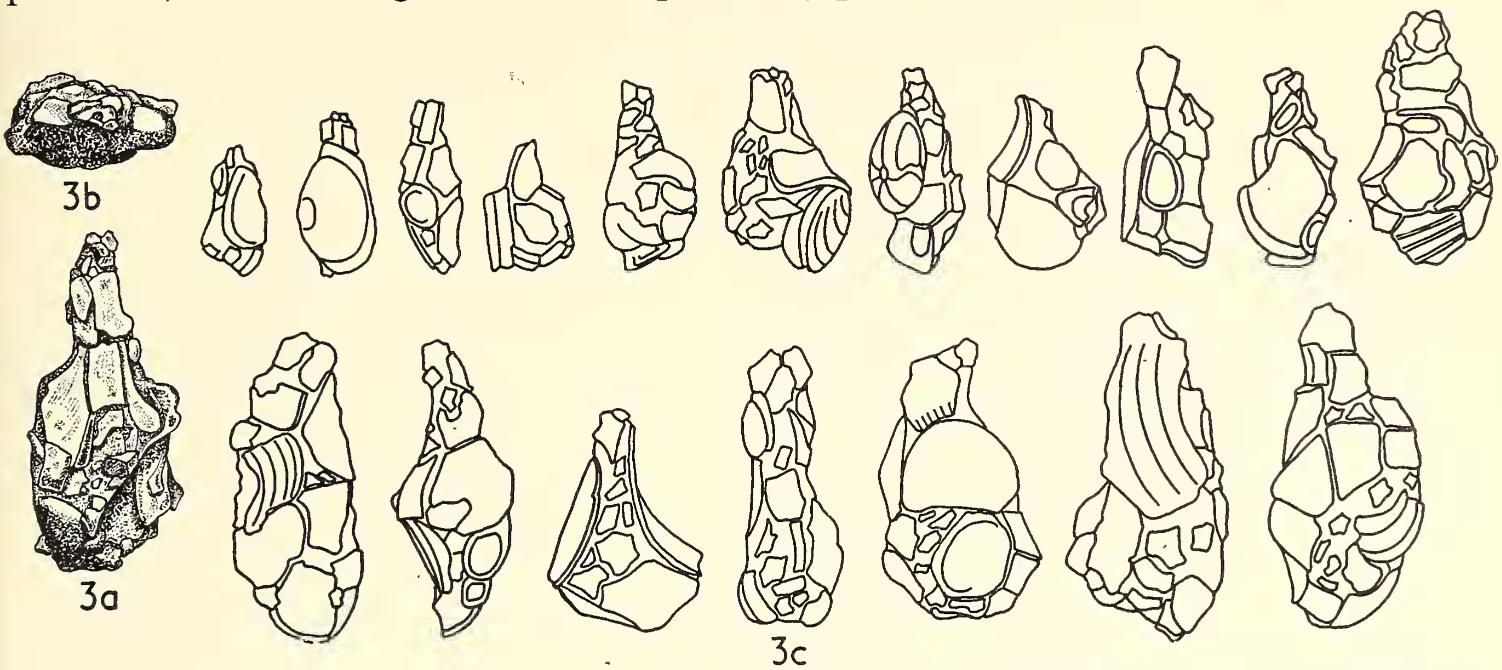
Plate 54, fig. 5; text-fig. 3

Diagnosis. Test sub-ovoid to flask-shaped, often elongate. Cross-section round to compressed. Agglutinated material large shell fragments, frequently cemented edge to edge with little cement (type not ascertained). Small shell fragments and quartz grains used to a minor degree. The aperture is small, circular, terminal, often with a slender neck.

Type locality and horizon. Thirty-five ft. above the base of the *mutabilis* zone of Black Head, near Osmington Mills, Dorset. Grid Ref. 30/727.818. Sample Do-Mu 3.

Remarks. This species, owing to its habit of agglutinating large shell fragments, is variable in shape (Paratypes—text-fig. 3), but certain trends are common. The test is usually at least twice as long as it is broad, and curved shell fragments are often mounted with the concave side out, particularly in the region of the aperture so that a slender neck is not unusual. Fragments of lamellibranch and ammonite shells are the usual material but young lamellibranchs, gastropods, ostracods, and other foraminifera may be included. Quartz grains occur in small quantities, a marked difference to *P. difflugi-*

formis from the same horizon where quartz is dominant and broken shell fragments rare. *P. conferrens* was confined to a single sample (Do-Mu 3), represented by eighty-six specimens, with the original cement replaced by pyrite in all cases.



TEXT-FIG. 3. *Proteonina conferrens* sp. nov. 3*a*, *b*, Lateral and apertural views of holotype, P. 43982 (see Pl. 54, fig. 5), ×42·5. 3*c*, Camera lucida drawings of paratypes, P. 43983, ×36; *mutabilis* zone, Black Head, near Osmington Mills, Dorset.

Reophax sterkii Haeusler

Plate 54, figs. 6*a*, *b*

Reophax sterkii Haeusler 1890, p. 26, pl. 3, fig. 23.

Description. The slightly compressed test consists of three or four chambers in a straight or gently curved series. Early chambers are wider than high, the end chamber tapers to a broad apertural neck and makes up more than half of the test. The sutures are indistinct. The agglutinated material is 80–100 μ quartz in the *cymodoce* zone but in the *mutabilis* zone it is 60 per cent. large shell fragments and 40 per cent. fine-medium quartz. The aperture is simple, circular to oval, terminal.

Remarks. Recent species of similar form have either been placed as varieties of *R. scorpiurus* Montfort or referred to new species, as were *R. curtus* Cushman 1920 and *R. subfusiformis* Earland 1933. Both authors extracted figures from *R. scorpiurus* Montfort, Goes 1894, and Hoglund (1947, pp. 77–86) considers these new species synonymous. The only similar form described from Jurassic rocks is *R. sterkii.* This species was seen in the *cymodoce* and *mutabilis* zones.

Reophax cf. *variabilis* Herrmann 1917 *non* Haeusler 1885.

Plate 54, fig. 13

Cf. *Reophax variabilis* Herrmann 1917, p. 286, pl. 2, figs. 19*a–c*.

Description. The test consists of three or four globose chambers in a straight or curved series. Each chamber is wider than high in lateral view and circular in cross-section. The agglutinated material is 40–60 μ quartz grains, set separately in a fine, white, calcareous cement. The aperture is simple, circular, terminal, sometimes with a short neck. Occurs rarely in the *mutabilis* zone.

Reophax scorpiurus de Montfort

Plate 54, fig. 15

Reophax scorpiurus de Montfort 1808, p. 331, fig. on p. 330.
Nodulina scorpiurus (Montfort), Paalzow 1917, p. 18, pl. 41, fig. 10.

Description. The test consists of a sub-linear series of five or six elongate chambers, circular in cross-section, separated by distinct, depressed sutures. Successive chambers show a gradual increase in height and breadth. The agglutinated material is 20–40 μ quartz with a little pyrite set in a calcareous cement. The aperture is simple, circular and terminal. Occurs rarely in the *baylei* zone.

Reophax helvetica Haeusler

Plate 54, fig. 8

Dentalina helvetica Haeusler 1881, p. 34, pl. 2, fig. 45.
Reophax helvetica Haeusler 1883*b*, p. 27, pl. 2, figs. 8–10.
Reophax helvetica Haeusler 1890, p. 28, pl. 3, figs. 15–17.
Nodulina compressa Paalzow 1917, p. 18, pl. 41, figs. 11, 12.
Reophax agglutinans (Terquem), Paalzow 1932, p. 92, pl. 4, figs. 8, 9.
Reophax multilocularis Haeusler, Bartenstein and Brand 1937, p. 133, pl. 5, fig. 8; pl. 6, fig. 9; pl. 8, figs. 8*a*, *b*; pl. 10, fig. 9; pl. 11*a*, fig. 5; pl. 15*a*, fig. 4; pl. 15*c*, fig. 2.

Description. The test is a linear series of three to five chambers, each sub-rectangular in lateral view and with a slightly compressed, oval cross-section. The sutures are straight and gently depressed. The agglutinated material is 15–40 μ quartz with a little pyrite sometimes included. The aperture is simple, circular, terminal, rarely set on a short, thick neck.

Remarks. In lateral view the margins of most forms diverge at a low angle. Those in which the angle of divergence is higher approach *R. metensis* Franke 1936 which is otherwise distinct. This species is frequent from the *baylei* zone to the middle of the *mutabilis* zone.

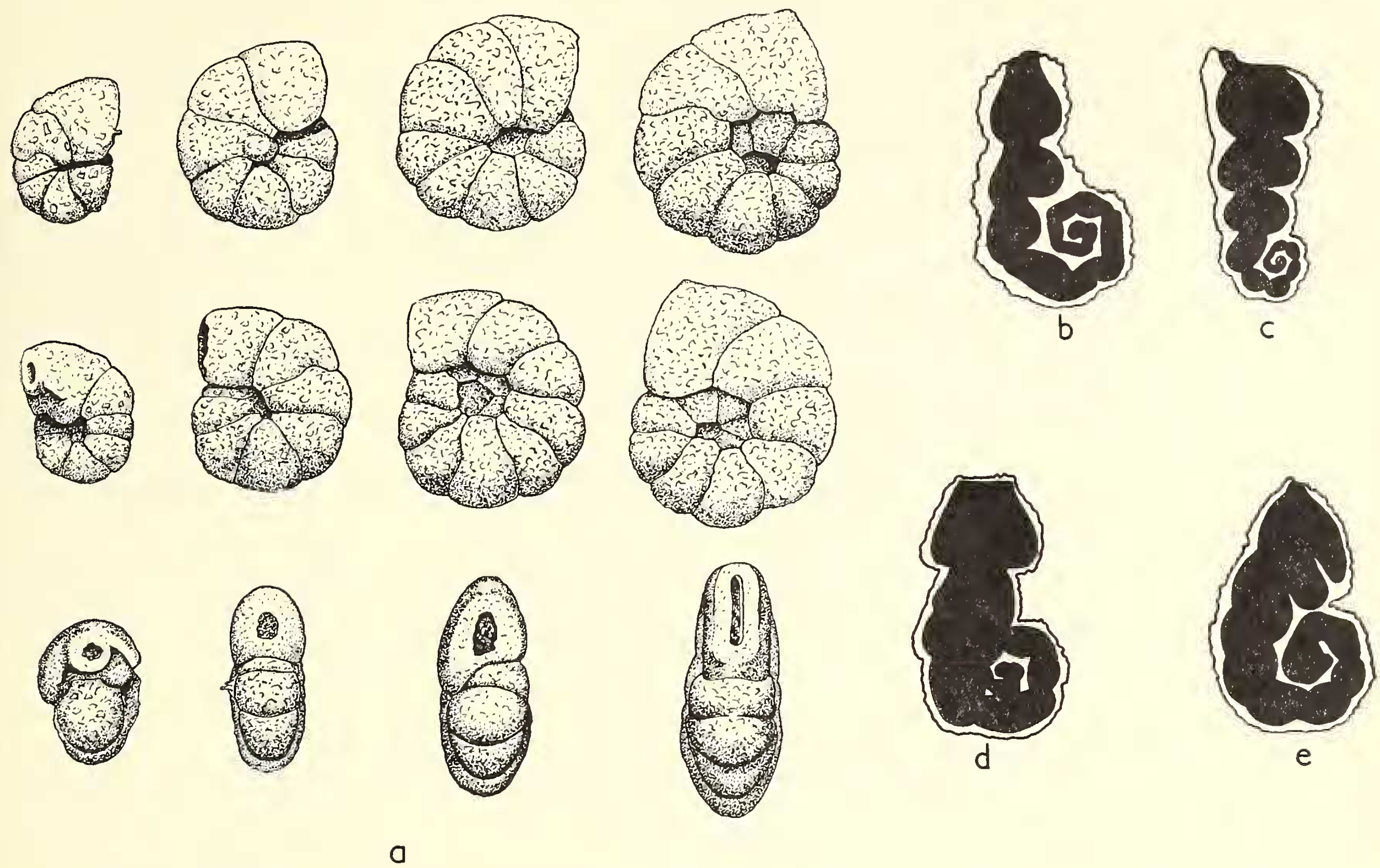
Reophax hounstoutensis sp. nov.

Plate 54, figs. 7*a*, *b*; text-figs. 5*d*, *e*

Diagnosis. The test is a rectilinear series of four to seven chambers. The proloculum is large and sub-spherical, the second chamber wider than high. More distal chambers become progressively wider but their heights remain the same. The sutures are depressed but due to the coarse grain size are indistinct. Agglutinated material is 70–80 μ quartz with occasional larger grains, closely packed with a little calcareous cement. The outer surface is extremely rough. In all the specimens examined no trace of an aperture could be found anywhere on the test.

Type locality and horizon. Near the top of the *Rhynchonella* Marls (*rotunda* zone) of Hounstout, near Kingston, Dorset. Grid ref. 30/950773. Sample Do-Pa 15.

Remarks. This species was rare in the upper part of the *Rhynchonella* Marls and in the Hounstout Clay. Some variation occurred in the angle of divergence of the margins when seen in lateral view. Only one size of proloculum was observed.



TEXT-FIG. 4. *Ammobaculites spp.* 4*a*, Obverse, reverse, and apertural views of four specimens, showing the ontogeny of *A. laevigatus* Lozo, P. 43968–71, ×34; *baylei* zone, Black Head, near Osmington Mills, Grid ref. 30/727818. 4*b–e*, Pyrite-infilled specimens immersed in clove oil and drawn by transmitted light. 4*b*, *A. agglutinans* A, P. 43961, ×47. 4*c*, *A. agglutinans* B, P. 43960, ×36. 4*d*, *A. agglutinans* C, P. 43959, ×55. 4*e*, *A.* cf. *hockleyensis*, P. 43962, ×65.

Ammobaculites agglutinans (d'Orbigny)

Plate 54, figs. 9–11; text-figs. 4*b–d*

Spirolina agglutinans d'Orbigny 1846, p. 137, pl. 7, figs. 10–12.
Haplophragmium coprolithiforme Schwager, Paalzow 1922, p. 31, pl. 5, fig. 3.
Ammobaculites coprolithiformis (Schwager), Paalzow 1932, p. 94, pl. 4, fig. 19.
Ammobaculites agglutinans (d'Orbigny), Bartenstein and Brand 1937, p. 186, pl. 4, fig. 14; pl. 5, fig. 78; pl. 6, figs. 40*a*, *b*; pl. 8, figs. 38*a–c*; pl. 10, figs. 45*a*, *b*; pl. 11*a*, figs. 19*a*, *b*; pl. 12*a*, fig. 22; pl. 13, fig. 23; pl. 14*b*, fig. 19.
Ammobaculites infravolgensis Myatliuk 1939, p. 45, pl. 2, figs. 17*a*, *b*, 18.
Ammobaculites agglutinans (d'Orbigny), Bielecka and Pozaryski 1954, p. 158, pl. 2, figs. 3*a–c*.

Description. The test is an evolute, planispiral coil of two whorls, with five or six chambers in the last whorl, followed by two to four chambers in a rectilinear, uncoiled series. Sutures and umbilicus may be indistinct but are usually depressed. The preferred material agglutinated is 20–40 μ quartz, but fine quartz with subordinate pyrite may be used. The cement is calcareous. In the adult the aperture is circular and central in the terminal face of the end chamber.

Remarks. Variation occurs in the tightness of coiling, amount of depression of the sutures and umbilicus, and to a lesser extent in the size of the coil and chamber shape. Three variants are distinguished. Of the three, A (Pl. 54, fig. 9; text-fig. 4*b*) has the most evolute coil but the umbilicus is not well defined and the sutures are depressed only in the linear part. This common variant from the *baylei* zone to the middle of the *mutabilis* zone becomes infrequent later. The circular cross-section of the linear part allows it to be separated from the otherwise similar *A.* cf. *hockleyensis*. Variant B (Pl. 54, fig. 10; text-fig. 4*c*) also has an evolute coil but the umbilicus is distinct and all sutures in the last whorl of the coil and the uncoiled part are depressed. This, the most common variant, occurs throughout the Kimeridgian. Variant C (Pl. 54, fig. 11; text-fig. 4*d*) is more involute than the others but has a small, deep umbilicus; all sutures are depressed and in the linear part the chambers are widest near their proximal sutures; it occurs only in the *baylei*, *cymodoce*, and *mutabilis* zones.

Spirolina agglutinans, though a Tertiary form from the Vienna Basin was figured and described as close to the Kimeridgian specimens. Similar forms originally described from the Jurassic are *A. infravolgensis* Myatliuk, which differs only in having five or six chambers in the coil, and *A. suprajurassicus* (Schwager) as revised by Seibold and Seibold (1956, p. 105, text-fig. 3*h*; pl. 7, fig. 16). The latter differs only in minor respects and should, perhaps, be considered synonymous with the present form.

Ammobaculites cf. *hockleyensis* Cushman and Applin

Plate 54, fig. 19; text-fig. 4*e*

Cf. *Ammobaculites hockleyensis* Cushman and Applin 1926, p. 163, pl. 6, fig. 2.

Description. The test consists of an evolute, planispiral coil of two whorls followed by a short, laterally compressed uncoiled part of two chambers. The agglutinated material is 20–40 μ quartz, close set in a calcareous cement. The aperture is simple, terminal, a short slit at the apex of the end chamber.

Remarks. The species described by Cushman and Applin (1926) from the Jackson Formation (Up. Eocene) differs only in its involute coil, however, the Kimeridgian specimens also appeared involute till they were immersed in clove oil. Occurs rarely in the *mutabilis* zone.

Ammobaculites deceptorius (Haeusler)

Plate 54, figs. 24*a*, *b*

Reophax sp. indet. Haeusler 1890, p. 30, pl. 3, fig. 13.
Bigenerina deceptoria Haeusler 1890 (pars), p. 74, pl. 12, figs. 11–13.
Ammobaculites praelonga ten Dam 1944, p. 80, pl. 6, fig. 9.

Description. The initial 'coil' consists of two globular chambers placed side by side, and is followed by three to six chambers in a straight or gently curved series. The linear chambers are globular with depressed, transverse sutures, and a circular cross-section. The distal end of the last chamber is drawn out into a stout apertural neck. The agglutinated material is fine-grained quartz or globular pyrite. The aperture is simple, round, terminal, mounted on a neck, central in the terminal face of the last chamber. Occurs commonly from the *baylei* to *mutabilis* zones and from the *vimineus* sub-zone to the top of the formation.

Ammobaculites cf. *coprolithiformis* (Schwager)

Plate 54, figs. 12*a*, *b*

Cf. *Haplophragmium coprolithiforme* Schwager 1867, p. 654, pl. 34, fig. 3.

Description. A small evolute coil of two whorls, the whorl height increasing rapidly, is followed by a rectilinear series of four or five chambers, each wider than high and wider parallel to the axis of coiling than normal to it. The sutures are gently depressed in the linear part but indistinct in the coil. The agglutinated material is coarse quartz or shell fragments up to 240 μ in diameter, set in a matrix of 30 μ quartz which itself has a calcareous cement. The aperture is simple, round, terminal.

Remarks. This species is rare in the *baylei* and *mutabilis* zones.

Ammobaculites subaequalis Myatliuk

Plate 54, figs. 16, 17

Ammobaculites subaequalis Myatliuk 1939, p. 44, pl. 2, figs. 19, 20.

Description. The large test consists of an involute coil with four or five chambers in the last whorl, followed by an uncoiled part of one or two chambers. The sutures are depressed, radial in the coil, and nearly transverse in the linear part. The inflated chambers in the coil are followed by the first uncoiled chamber, twice the size of its predecessor, which in turn is followed by a sub-globular end chamber with a short, stout apertural neck. The agglutinated material is 40–60 μ quartz grains, closely set with little calcareous cement. The aperture is simple, circular, mounted on a neck, central in the terminal face of the end chamber.

Remarks. This form was common from the middle of the *mutabilis* zone to the base of the *pseudomutabilis* zone. It always occurred with *A. braunsteini.*

Ammobaculites braunsteini Cushman and Applin

Plate 54, figs. 20, 21

Ammobaculites braunsteini Cushman and Applin 1946, p. 76, pl. 13, figs. 7*a*, *b*.
Ammobaculites braunsteini Cushman and Applin, Bielecka and Pożaryski 1954, p. 160, pl. 2, figs. 5*a*, *b*.

Description. The large test consists of an involute coil with six or seven chambers in the last whorl and a deep but narrow umbilicus, followed by one or two uncoiled chambers. The sutures are depressed, sub-radial in the coil where they may be sinuous, always

EXPLANATION OF PLATE 54

All figures ×33. The specimens are in the British Museum (Natural History).

Figs. 1–4. *Proteonina difflugiformis* (Brady). 1, Variant A, *baylei* zone, P. 43951, length 0·28 mm., max. width 0·21 mm. 2, Variant C, *cymodoce* zone, P. 43953, length 0·38 mm., max. width 0·25 mm. 3, Variant B, *cymodoce* zone, P. 43952, length 0·43 mm., max. width 0·25 mm. 4, Variant D, *baylei* zone, P. 43954, length 0·49 mm., max. width 0·21 mm.

Fig. 5. *Proteonina conferrens* sp. nov., holotype, *mutabilis* zone, P. 43982, length 0·74 mm., max. width 0·36 mm.

Fig. 6*a*, *b*. Lateral view and clove-oil 'section' of *Reophax sterkii* Haeusler, *cymodoce* zone, P. 43955, length 0·72 mm., max. width 0·40 mm.

Fig. 7. *Reophax hounstoutensis* sp. nov., holotype, *Rhynchonella* Marls, *rotunda* zone, P. 43984, length 1·0 mm., max. width 0·47 mm.; *a*, lateral view; *b*, chamber arrangement.

Fig. 8. *Reophax helvetica* Haeusler, *mutabilis* zone, P. 43958, length 0·78 mm., max. width 0·25 mm.

Figs. 9–11. *Ammobaculites agglutinans* (d'Orbigny). 9, Variant A, *baylei* zone, P. 43961, length 1·0 mm., width of coil 0·32 mm. 10, Variant B, Crushed Ammonoid Shales, *rotunda* zone, P. 43960, length 0·69 mm., width of last chamber 0·28 mm., width of coil 0·24 mm. 11, Variant C, *baylei* zone, P. 43959, length 0·45 mm., width of coil 0·22 mm.

Fig. 12*a*, *b*. Lateral view and clove-oil 'section' of *Ammobaculites* cf. *coprolithiformis* (Schwager), *baylei* zone, P. 49364, length 1·05 mm., width of coil 0·38 mm.

Fig. 13. *Reophax* cf. *variabilis* Herrmann, *mutabilis* zone, P. 43956, length 0·69 mm., max. width 0·36 mm.

Fig. 14. *Ammobaculites laevigatus* Lozo, *baylei* zone, P. 43971, height 0·71 mm., width 0·62 mm.

Fig. 15. *Reophax scorpiurus* Montfort, *baylei* zone, P. 43957, length 0·62 mm., max. width 0·18 mm.

Figs. 16, 17. *Ammobaculites subaequalis* Myatliuk, *mutabilis* zone. 16, Young form, height 0·60 mm., width 0·50 mm., P. 43966. 17, Adult, P. 43967, height 1·08 mm., width 0·56 mm.

Fig. 18. *Ammobaculites sp. juv.*, *pectinatus* zone, P. 43972, height 0·29 mm., width 0·26 mm.

Fig. 19. *Ammobaculites* cf. *hockleyensis* Cushman and Applin, *mutabilis* zone, P. 43962, length 0·39 mm., width of coil 0·25 mm.

Figs. 20, 21. *Ammobaculites braunsteini* Cushman and Applin, *pseudomutabilis* zone. 20, Young form, P. 43965, height 1·13 mm., width 1·03 mm. 21, Adult, P. 43986, height 2·13 mm., width of coil 1·34 mm.

Fig. 22. *Haplophragmoides haeusleri* sp. nov., holotype, *Rhynchonella* Marls, *rotunda* zone, P. 43985, height 0·89 mm., width 0·69 mm.

Fig. 23*a*, *b*. Lateral and apertural views of *Haplophragmoides latidorsatum* (Bornemann), Crushed Ammonoid Shales, *rotunda* zone, P. 43973, height 0·29 mm., width 0·26 mm.

Fig. 24*a*, *b*. Lateral view and clove-oil 'section' of *Ammobaculites deceptorius* (Haeusler), Crushed Ammonoid Shales, *rotunda* zone, P. 43963, length 0·64 mm., width of last chamber 0·21 mm.

Fig. 25. *Textularia agglutinans* d'Orbigny, *baylei* zone, P. 43974, length 0·39 mm., max. width 0·19 mm.

Fig. 26. *Textularia jurassica* (Gümbel), Crushed Ammonoid Shales, *rotunda* zone, P. 43975, length 0·36 mm., max. width 0·14 mm.

Fig. 27. *Textularia auensteinensis* (Haeusler), *pectinatus* zone, P. 43976, length 0·39 mm., max. width 0·11 mm.

Fig. 28. *Spiroplectammina biformis* (Parker and Jones), *wheatleyensis* zone, P. 43977, length 0·47 mm., max. width 0·15 mm., width of coil 0·10 mm.

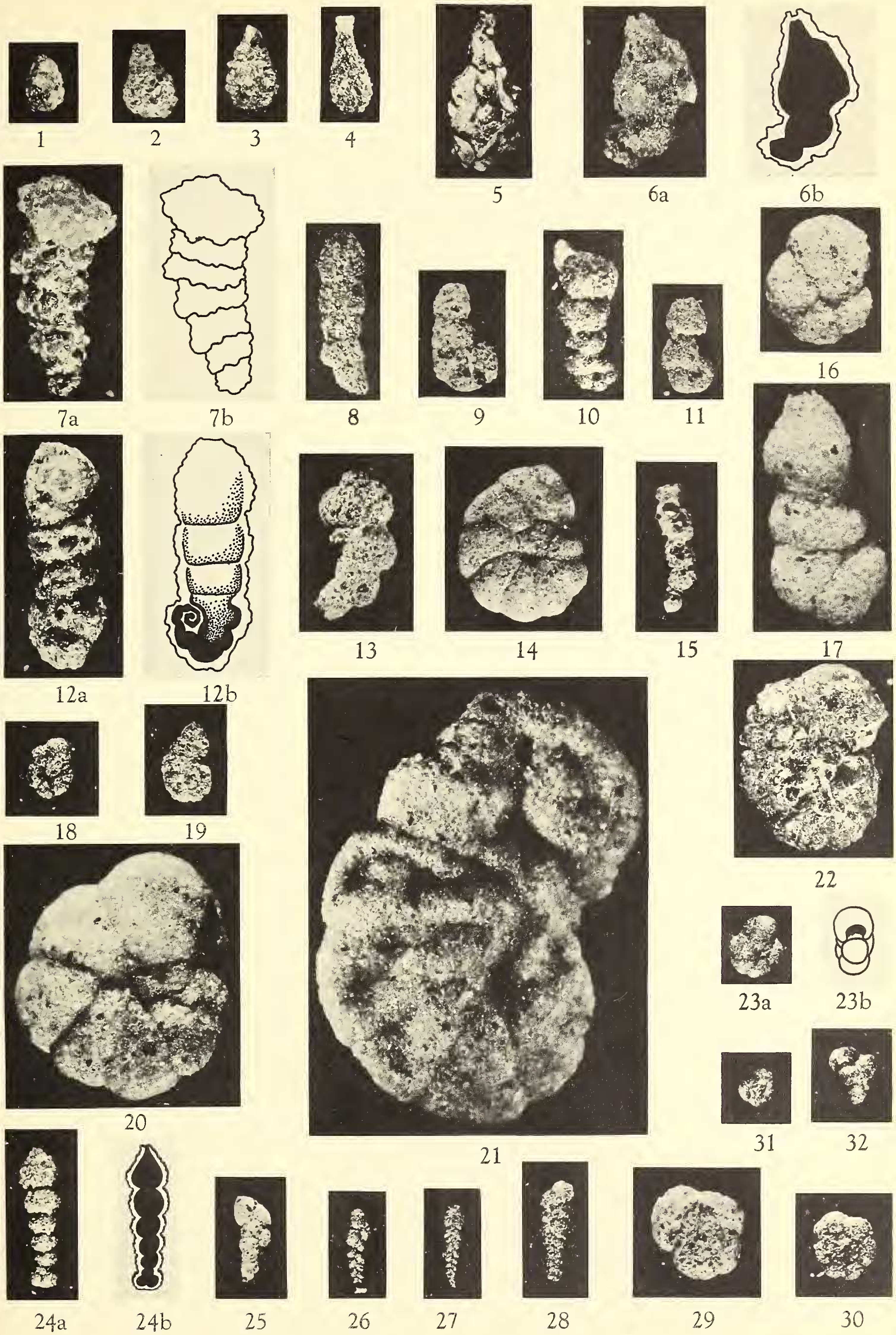
Fig. 29. *Trochammina squamata* Jones and Parker, *baylei* zone, P. 43978, max. diameter 0·32 mm.

Fig. 30. *Trochammina* cf. *nitida* Brady, Crushed Ammonoid Shales, *rotunda* zone, P. 43979, max. diameter 0·32 mm.

Fig. 31. *Trochammina globigeriniformis* (Parker and Jones), *pectinatus* zone, P. 43980, max. diameter 0·18 mm.

Fig. 32. *Eggerella? meentzeni* (Klingler), *mutabilis* zone, P. 43981, height 0·27 mm., max. width 0·22 mm.

Localities. Figs. 1–6, 8, 9, 11–17, 19–21, 25, 29, 32 from Black Head, near Osmington Mills, Dorset, Grid ref. 30/727818. Figs. 7, 10, 22–24, 26, 27, 30 from Hounstout, near Kingston, Dorset, Grid ref. 30/947773. Figs. 18, 31 from Freshwater Steps, near Kingston, Dorset, Grid ref. 30/942773. Fig. 28 from Rope Lake Head, near Kimeridge, Dorset, Grid ref. 30/927775.



LLOYD, Kimeridgian Foraminifera x 33

sinuous in the linear part. The cross-section of the coil chambers is sub-triangular with a narrow, but rounded, periphery; that of the linear chambers oval. Agglutinated material is 20–60 μ quartz, closely set with little calcareous cement. The aperture is simple, central in the terminal face and appears to be oval, though the shape has often been distorted by crushing.

Remarks. A. braunsteini has a similar range to *A. subaequalis* from which it can be separated by the greater number of chambers in the coil, absence of an apertural neck; sinuous sutures and an oval aperture, though the latter two characters may owe their origin to the crushed nature of all specimens found.

Ammobaculitus laevigatus Lozo

Plate 54, fig. 14; text-fig. 4*a*

Ammobaculites laevigata Lozo 1944, p. 539, pl. 2, figs. 2, 3; text-figs. 14*a–h*.

Description. The test consists of a coil of three or four whorls, the early whorls involute with seven or eight chambers each. The later whorls, with nine or ten chambers each, become increasingly evolute and asymmetrical so that more of the early chambers is exposed on one side than the other. The depressed sutures are radial in the initial stages but later are recurved to the lobulate periphery. A few specimens have an uncoiled part of one laterally compressed chamber. The agglutinated material is fine-grained quartz with little calcareous cement. The aperture is simple and central in the terminal face of the last chamber, circular in the young form, becoming a median slit in the adult. The ontogeny is shown on text-fig. 4*a*.

Remarks. A. laevigatus was common in the lowest foot of the *baylei* zone.

Ammobaculites sp. juv.

Plate 54, fig. 18

Description. The test is a small evolute coil of three whorls with seven chambers in the last whorl. Early chambers are sub-quadrate in cross-section, later they are sub-triangular. The depressed sutures are recurved. The agglutinated material is fine-grained quartz with little calcareous cement. The aperture is a low arch at the base of the terminal face.

Remarks. This form is similar to the juveniles of *A. agglutinans* but differs in still having a basal aperture where *A. agglutinans*, at the same size, has a central aperture. No corresponding adult was seen. Occurred rarely in the middle of the *pectinatus* zone and in the *rotunda* zone.

Haplophragmoides latidorsatum (Bornemann)

Plate 54, figs. 23*a*, *b*

Nonionina latidorsata Bornemann 1855, p. 339, pl. 16, fig. 4.
Haplophragmium latidorsatum (Bornemann), Haeusler 1890, p. 35, pl. 3, figs. 37, 38.
Haplophragmoides subglobosus (G. O. Sars), Bartenstein and Brand, p. 188, pl. 4, fig. 12.

Description. The test is an involute planispiral coil with five or six chambers in the last whorl. All chambers are globular, early chambers sub-circular in cross-section, adult chambers higher than wide but still with a rounded periphery. The sutures are depressed and radial. The agglutinated material is fine-grained quartz with a calcareous cement. The semicircular aperture is basal on the terminal face of the end chamber.

Remarks. This species was rare in the *baylei* zone, but frequent from the base of the *rotunda* zone to the top of the Hounstout Clay.

Haplophragmoides haeusleri sp. nov.

Plate 54, fig. 22; text-figs. 5*i*, *j*

Diagnosis. The test is an involute planispiral coil with five to six chambers in the last whorl. In axial section early chambers are sub-circular but later chambers are compressed with a rounded periphery. The sutures are radial, depressed, but obscured by the coarse grain size. The agglutinated material is 70–100 μ quartz with occasional glauconite and red garnet, close set with little calcareous cement. The aperture is semicircular, basal on the terminal face of the end chamber, with its peripheral margin clearly defined by a ring of 40 μ quartz grains.

Type locality and horizon. Near the top of the *Rhynchonella* Marls (*rotunda* zone) of Hounstout, near Kingston, Dorset. Grid ref. 30/950773. Sample Do-Pa 15.

Remarks. This species can be distinguished from *H. latidorsatum* (Born.) by its coarser-grained size, larger overall size, the more compressed cross-section and less lobate periphery of the adult chambers. It occurs rarely in the Crushed Ammonoid Shales and frequently from the middle of the *Rhynchonella* Marls to the top of the Hounstout Marls.

Textularia agglutinans d'Orbigny

Plate 54, fig. 25

Textularia agglutinans d'Orbigny 1839, p. 144, Plates vol. 8, pl. 1, figs. 17, 18, 32–34.
Textilaria jurassica Gümbel, var. *maxima* Haeusler 1881, p. 36, pl. 2, fig. 50.
Textularia agglutinans d'Orbigny, Haeusler 1890 (pars), p. 71, pl. 11, figs. 1–9, 47, 50, 52.

Description. In lateral view the margins of the biserial part diverge at an angle between 20° and 30°. The chamber size increases rapidly, the early chambers are wider than high, distal chambers may be as high as wide. The sutures are depressed and lateral sutures are normal to the long axis of the test. The agglutinated material is fine-grained quartz with little calcareous cement. The aperture is a high arch, basal on the terminal face.

Remarks. This species of *Textularia* is the largest in the Kimeridgian. The test is often twisted about its long axis through 90° or more. Occurs frequently in the *baylei* zone.

Textularia jurassica (Gümbel)

Plate 54, fig. 26

Textilaria jurassica Gümbel 1862, p. 228, pl. 4, fig. 17.
Textilaria franconica Gümbel 1862, p. 229, pl. 4, fig. 18.

Plecanium depravatum Schwager 1865, p. 93, pl. 2, fig. 3.
Textilaria flexa Kubler and Zwingli 1870, p. 35, pl. 4*i*, fig. 17.
Textilaria argoviensis Haeusler 1881, p. 36, pl. 2, figs. 61, 62.
Textilaria scyphiphila Uhlig 1881, p. 136, pl. 15, figs. 2, 3.
Textularia jurassica (Gümbel), Paalzow 1932, p. 94, pl. 4, figs. 21–23.
Textularia racemata (Terquem and Berthelin), Franke 1936, p. 125, pl. 12, fig. 20.
Textularia agglutinans d'Orbigny, Bartenstein and Brand 1937, p. 182, pl. 14*a*, figs. 5*a*, *b*; pl. 14*c*, fig. 16; pl. 15*a*, figs. 40*a–c*; pl. 15*b*, figs. 3*a–c*; pl. 15*c*, figs. 21*a*, *b*.
Textularia jurassica (Gümbel), Seibold and Seibold 1953, p. 43, pl. 4, fig. 2.
Textularia jurassica (Gümbel), Seibold and Seibold 1955, p. 98, text-figs. 2*a*, *b*; pl. 13, fig. 1.

Description. After the first few chambers the margins diverge at an angle between 8° and 18°. The early chambers are wider than high, later chambers sub-globular. All sutures are depressed, the lateral sutures normal to the long axis of the test. The agglutinated material is 5–10 μ pyrite or fine-grained quartz with a calcareous cement. The aperture is sub-circular on the basal suture of the end chamber.

Remarks. Variable characters include the size of the test at which sub-globular chambers first appear, the rapidity of the change to the sub-globular type which may be abrupt or transitional over seven or eight chambers, and the relative position of pairs of chambers with consequent modification of the median suture. Variation in the latter is wide. All intermediates can be found between a form with chambers tending to lie side by side and a median suture of alternate long and short elements, and a form in which successive chambers are nearly superposed and the lateral sutures are shortened so that a cuneiform, uniserial condition is approached.

T. jurassica was common from the *baylei* to *rotunda* zones.

Textularia auensteinensis (Haeusler)

Plate 54, fig. 27

Textilaria auensteinensis Haeusler 1881, p. 40, pl. 2, fig. 72.
Textilaria alsatica Andreae 1884, p. 214, pl. 6, figs. 5*a*, *b*.
Textilaria oxfordiana Deecke 1886, p. 324, pl. 1, fig. 24.

Description. For most of the test the margins diverge at an angle between 10° and 12°. All chambers are twice as wide as high and are never inflated. The sutures are gently depressed, the lateral sutures lie obliquely to the long axis of the test at angles between 50° and 60°. The agglutinated material is fine-grained quartz or pyrite. The aperture is a semicircular opening on the basal suture of the end chamber.

Remarks. Occurs rarely from the *grandis* sub-zone to the *rotunda* zone.

Spiroplectammina biformis (Parker and Jones)

Plate 54, fig. 28

Textularia agglutinans d'Orbigny, var. *biformis* Parker and Jones 1865, p. 370, pl. 15, figs. 23*a*, *b*.
Spiroplectammina biformis (Parker and Jones), Bartenstein and Brand 1937, p. 183, pl. 2*b*, fig. 39.

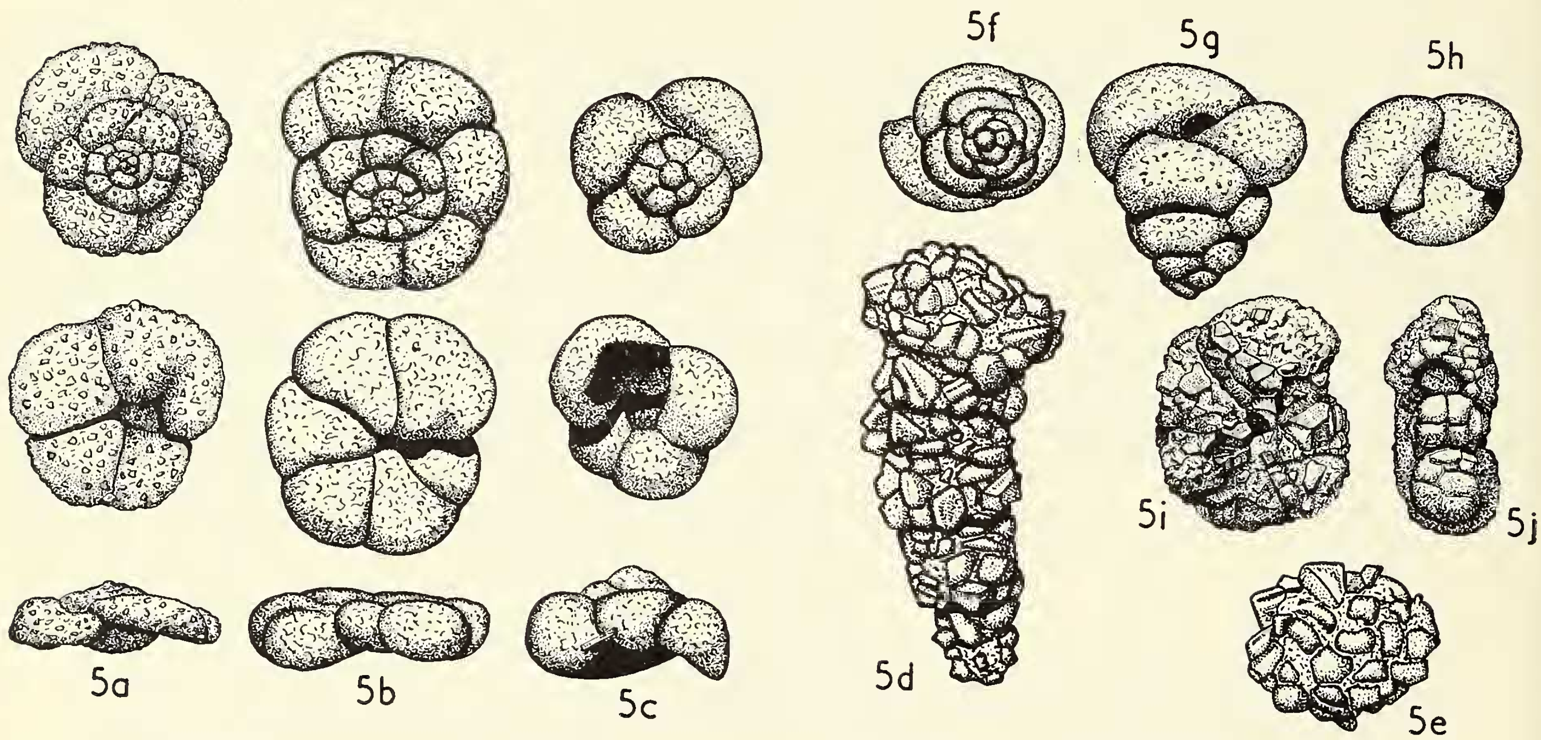
Description. The test consists of an initial evolute coil of six chambers, arranged in a single whorl, followed by a biserial part closely similar to that of *T. jurassica* but with larger chambers. The agglutinated material is pyrite or fine-grained quartz. The aperture is a semicircular opening on the basal suture of the end chamber.

Remarks. It is possible that these forms are microspheres of *T. jurassica*. Occurs frequently in the *wheatleyensis* sub-zone and rarely in the *pectinatus* zone.

Trochammina squamata Jones and Parker

Plate 54, fig. 29; text-fig. 5*a*

Trochammina squammata Jones and Parker 1860, p. 304.
Trochammina squamata Jones and Parker, Paalzow 1932, p. 96, pl. 4, figs. 24–26.
Trochammina squamata Jones and Parker, Bartenstein and Brand 1937, p. 190, pl. 6, fig. 41; pl. 11*b*, fig. 29; pl. 15*c*, figs. 22*a*, *b*.



TEXT-FIG. 5. *Trochammina*, *Reophax*, *Haplophragmoides*, and *Eggerella?* 5*a*, Dorsal, ventral, and lateral views of *Trochammina squamata*, P. 43978, ×41, *baylei* zone, Black Head, near Osmington Mills, Grid ref. 30/727818. 5*b*, Dorsal, ventral, and lateral views of *T.* cf. *nitida*, P. 43979, ×72·5, Crushed Ammonoid Shales, *rotunda* zone, Hounstout, Grid ref. 30/947773. 5*c*, Dorsal, lateral, and ventral views of *T. globigeriniformis*, P. 43980, ×102·5, *pectinatus* zone, Freshwater Steps, Grid ref. 30/942773. 5*d*, *e*, Lateral and terminal views of *Reophax hounstoutensis* sp. nov., holotype, P. 43984, ×36. 5*f*, *g*, *h*, Lateral, initial, and terminal views of *Eggerella? meentzeni*, P. 43981, ×82, *mutabilis* zone, Black Head, near Osmington Mills, Grid ref. 30/727818. 5*i*, *j*, Lateral and peripheral views of *Haplophragmoides haeusleri* sp. nov., holotype, P. 43985, ×43·5.

Description. Test trochospiral. The ventral surface is gently concave with only the four to seven chambers of the last whorl visible. The dorsal side is a low spire with three or four whorls exposed. The sutures are depressed. The agglutinated material is a mixture of fine and medium quartz set in a calcareous cement. The aperture is semicircular, basal on the ventral spiral suture of the end chamber.

Remarks. Occurs frequently from the *baylei* zone to the *mutabilis* zone.

Trochammina cf. *nitida* Brady

Plate 54, fig. 30; text-fig. 5*b*

Cf. *Trochammina nitida* Brady 1881, p. 52, pl. 41, figs. 5, 6.

Description. Test trochospiral, discoidal. The ventral surface is gently convex with the five to seven chambers of the last whorl visible. The dorsal surface may be either gently convex or concave with three or four whorls exposed. The sutures are distinct but little depressed. The agglutinated material is fine-grained quartz or pyrite with a calcareous cement. The aperture is semicircular, ventral on the basal suture of the end chamber.

Remarks. Occurs rarely from the *mutabilis* to *pallasioides* zones.

Trochammina globigeriniformis (Parker and Jones)

Plate 54, fig. 31; text-fig. 5*c*

Lituola nautiloidea Lamarck, var. *globigeriniformis* Parker and Jones 1865, p. 407, pl. 15, figs. 46, 47; pl. 17, figs. 96–98.
Trochammina globigerinoides Haeusler 1882, p. 352, pl. 15, figs. 8, 9.
Trochammina globigerinoides Haeusler 1890, p. 66, pl. 10, figs. 20–22.
Trochammina globigeriniformis (Parker and Jones), Bartenstein and Brand 1937, p. 189, pl. 1*a*, fig. 21; pl. 4, fig. 13; pl. 5, fig. 76.
Trochammina globigeriniformis (Parker and Jones), Seibold and Seibold 1953, p. 46, fig. 5, 2.

Description. Test small, trochospiral. The ventral surface has a deep but narrow umbilicus. The dorsal surface is a well-developed spire with $1\frac{1}{2}$ to $2\frac{1}{2}$ whorls exposed. There are usually four globular chambers in the last whorl, separated by deeply depressed sutures. The agglutinated material is medium or fine quartz or pyrite. The semicircular aperture is basal on the ventral spiral suture.

Remarks. Occurs frequently throughout the Kimeridgian.

Eggerella? meentzeni (Klingler)

Plate 54, fig. 32; text-figs. 5*f–h*

Valvulina meentzeni Klingler 1955, p. 201, pl. 12, figs. 13*a–c*.

Description. Test trochospiral. The globular proloculum is followed by a whorl with 4 to $4\frac{1}{2}$ chambers. Later whorls show a regular reduction in the number of chambers though triserial to biserial or uniserial. There is sometimes an increase in the number of chambers in the last whorl. All chambers are inflated with depressed sutures. The agglutinated material is 10–20 μ quartz with little calcareous cement. The aperture in forms with a polyserial last whorl is semicircular and basal. In the terminally uniserial forms it is circular, central in the apertural face which may be directed at right angles to the axis of coiling.

Remarks. Twenty individuals were found in the *mutabilis* zone and two at the top of the *pectinatus* zone.

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